MELEES – e-support or mayhem?

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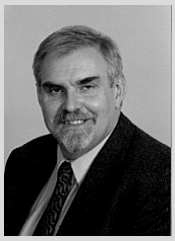

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This paper reports on progress in developing a web-based environment to support non-specialist mathematics students taking University level Mathematics as a compulsory subject in their first and second years. The scale and diversity of the service teaching provision at Nottingham invites the use of a technology-based framework in order to make available the 'good practice' features developed both locally and elsewhere. Initially the two-year development is focusing on{

- establishing a supportive environment;
- providing feedback to students, their lecturers and importantly to their home Schools;
- identifying and supporting e-learning strategies;
- improving student motivation;

Current activities have been primarily directed to the first three bullet points.

The e-learning project MELEES (Mathematical Electronic Learning Environment in Engineering and Science) aims to develop a dedicated infrastructure for the non-specialist mathematics (service) provision to Engineering and Science. The framework enables existing local e-learning initiatives to become embedded and to assist teaching staff in providing learning support materials. An important element is to incorporate existing learning materials available from ongoing HEFCE and other initiatives such as FDTL and TLTP together with wider availability such as collated by the LTSN Engineering and LTSN Maths, Stats & OR Network.

The principal challenge within the service teaching of mathematics is to address the needs of students who have not chosen the subject as a main area of study. Such students are often not provided *per se* with as extensive a support structure as that associated with their main subject area(s). It is important to note, as Prosser and Trigwell [1] suggest, that students' perceptions of their situation are related to their learning outcomes. As Petocz and Reid [2] assert, it is therefore critical to enhance the learning environment in mathematics with an appropriate structure, and to ensure that students are aware of the existence of this structure and the support it can provide them. Such a learning environment involves balancing the needs of the curriculum (content, assessment and outcomes) and of the participants (students, tutors and lecturers) for whom support can be provided at a number of levels. In a service teaching environment the stakeholders of the students programmes in client subjects are also both contributors and consumers. Providing links to the students overall programme of study, and the relationships with mathematics, will enable students to appreciate the importance and relevance of their mathematical knowledge and skills to their chosen degree programme.

Background to Service Teaching of Mathematics at Nottingham

The School delivers a first-year provision to non-specialist students of mathematics to Engineering and Built Environment (5 modules; over 500 students); Science (5 modules; over 300 students) and Foundation (4 modules; 50 students). In addition, Engineering and Foundation elements of this provision (5 modules) are given at the University's campus in Malaysia (UNiM).

For all courses in Engineering, and those in Chemistry and Physics, a prior qualification in mathematics is a course pre-requisite and a flexible first-year mathematics provision is crucial to enable Schools to recruit and retain

students from wide backgrounds. The range of mathematics modules provides the seven main client schools with the capability to consider students with prior qualifications in mathematics ranging from GCSE, A/S or, as in most cases, differing A-level grades. This requires significant liaison with client schools to match the learning outcomes of their students with course requirements, to provide a range of support mechanisms for their students and to exchange feedback. This provision is continued within Engineering to a second year (6 modules; over 400 students) and optionally to the third/fourth year (5 modules; over 200 students).

Methodology

The principal methodology of the MELEES project is to harness the emerging e-learning capability for delivering more targeted and individual provision to students and their advisors. Lectures remain a well-tested and successful approach to mathematics teaching but to ensure high quality student learning a comprehensive programme of support must complement this. It is recognised that students themselves need to manage their own support informed by self or teacher-led assessments and facilitated by supporting classes, resource materials and increased awareness of their attained skills and subject-context. Important aspects of study, and in particular first-year support, that can be substantially enhanced by the use of a web-based learning environment are:

- information about the mathematics provision and individual modules;
- motivation for a subject that is only part of their studies through links to their subject curriculum;
- the transition to University level mathematics;
- comprehensive and coordinated access to module specific materials;
- the access to a range of external learning and self-assessment support materials;
- learning materials and motivation to support lectures;
- helping students determine their own learning strategies;
- provision of a framework for feedback on assessment and evaluation to students, their lecturers, postgraduate tutors and importantly to their personal tutors and course directors.

Implementation

Construction of the project environment started in September 2002 with the appointment of a Project Support Officer on a full-time, 3-month contract to develop the web-based structure of the learning environment and to assemble initial project materials. Module materials for a pilot Engineering Mathematics module HG1M01 (Calculus for Engineers) was in place for the start of the Session to monitor first-hand experiences of student use. A part-time Project Support Assistant started in January for the duration of the two-year project to help with the development and preparation of project materials, evaluation, dissemination and administrative aspects.

As a Content management System (CMS), WebCT underpins the environment and access to MELEES is through any internet access using Netscape or Internet Explorer. The site is protected for students through their University standard username and current password which gives access to general features, registered specific module information and individual summative and formative assessments. An unprotected sample version of the environment that gives a 'feel' is given from the URL: http://www.maths.nottingham.ac.uk/melees/sample. Password protection is at four levels: Instructor, Teaching support, Student and Pre-registration. Higher levels of access giving more global module access and assessment details is provided to module support staff and tutors in Client Schools and a highest level entry for module staff to add additional materials and implement changes. Pre-registration will be implemented in Summer 2003 to give information and guidance advice on Mathematics to students entering Science and Engineering courses on the modules to be undertaken but also to encourage greater preparedness prior to arrival and to encourage use of e-learning resources as part of an overall learning strategy.

Overview of the MELEES site

On logging-in to the MELEES site a top-level icon-based menu is provided such as illustrated in Fig 1. Menu

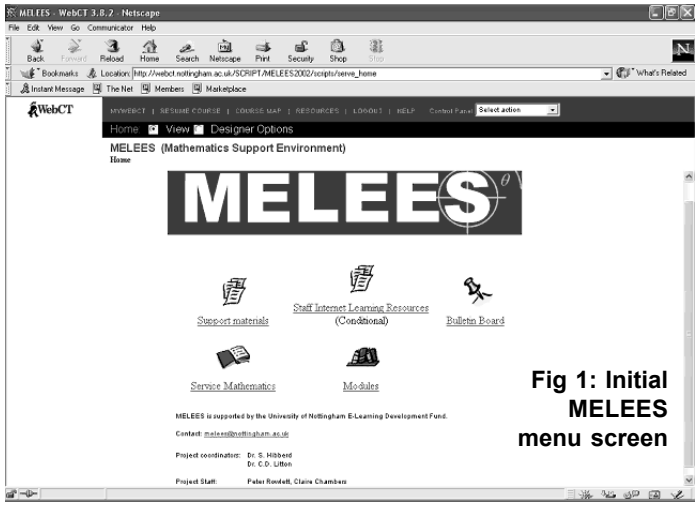

Fig 1: Initial MELEES menu screen

items are configured to the username registration and typically students will be directed to a subset of the available resources, configured by their choice of modules etc.

Functional features accessed through the icons for all students are:

Service Mathematics - initial information for students about to enter a University Course in Engineering that have a mathematics module on first-year modules (pre-requisites, options, course texts; revision materials, etc.). Key information for service mathematics modules for students from Client Schools (timetable, module descriptions, assessment details, option choices etc.)

Fig 2: List of utilities associated with the module HG1M01

Support Materials - support materials for students registered on an Engineering mathematics module. This will include generic support materials; University/ School interface support materials, general module information (timetable, detailed booklists, etc)

Modules - gateway to module-specific information according to student registration.

Staff Internet - a 'library' of useful internet sources for background information, technical and motivational materials. Additional items for teaching staff, postgraduate demonstrators, gateway information for national and international e-learning and teaching materials and information

Bulletin Board - general announcements and reminders; any MELEES user can post a message on the Bulletin Board that will then be visible to all MELEES users.

Items marked 'conditional' are only configured for users with a sufficiently high level of access.

Selecting the icon 'Modules' provides an additional menu displaying modules for which access is configured for each individual student based on their module registration. Module specific information is obtained directly from these individual module icons; an example is shown in Fig 2 for the first-year module HG1M01- 'Calculus for Engineers'.

Included items to date are:

Course Information – copies of key module information. Booklist, timetable, syllabus etc.

Bulletin Board –notices / information relevant to the module to be posted (from module teaching staff or students).

Coursework Assignments – copies of assignments set within the module; solutions available by timed release for viewing/printing. Copies of assignments and model solutions from the previous Session may be available for study or practice. Interactive self-assessment versions of multiple-choice class tests have been available. Guidance on plagiarism.

Example sheets and Solutions – copies of Example Sheets and Solutions, as distributed in Example Sessions. Full worked solutions made available by selective timed release for viewing/printing/downloading.

Past Examination papers and Solutions – copies and solutions of previous examination papers. For papers with multiple-choice section (HG1M01) the section is made available in the form of an interactive self-assessment test. Guidance on the management of exam stress.

Lecture Handouts – printed information relevant to the lecture; copies of handout distributed in lectures, copies of OHP slides, etc.

Teaching Resources - additional resources to be made available **only** to support staff, including advanced copies of Example or Coursework sheets. Information on student grades and attendance.

About MELEES – Information on scope and how to make use of MELEES

Internet Resources – A compilation of external internet links to selected web resources relevant to the module content and level (motivational, application and mathematical support). Web links to additional internal resources (individual teaching staff pages, library searches, etc.)

Study Tools – Individual feedback on summative assessment and attendance, support information for counselling, disability and study advice etc.

Self Assessment Exercises – provision of interactive dynamic self-assessment tests for formative feedback (diagnostic and practice)

Evaluation

The evaluation process is anticipated to be refined as the project develops but will look to incorporate the following main points:

- Continuous learning about development implementation Semester by Semester to incrementally inform the next stage.
- Promote feedback from Client Schools, students and Mathematics staff.
- Learn and reflect about the development process itself.
- Wide evaluation of the project outcomes.
- Provide dissemination information to Client Schools and teaching staff.

A key part of the project is an initial year-long period in which experience will be gained from consultation within the University and elsewhere and implemented on a limited number of modules carefully selected for development and evaluation. Such evaluation will use student-based and staff-based feedback loops to provide the basis for further development of these modules in the second year and to monitor improvements. Experience gained will also inform implementation of the provision to other modules in the second year and of the more extensive features planned. Success will be judged by:
i) implementation of an e-learning environment,
ii) the student uptake of the provision,
iii) feedback from students iv) feedback from client schools.

HG1M01 usage evaluation

Implementation was developed and evaluated for the Autumn Semester Engineering Mathematics module HG1M01; a compulsory module with a cohort of engineering first-year students without a recent A-level in mathematics and correspondingly has a very high proportion of mature students and those with non-standard qualifications.

The following information was recorded on student usage corresponding to 64 students registered on the module:

- 94% of students logged into MELEES (60 students);
- 80% of students logged into MELEES more than once;
- 87% of students using MELEES logged into the site after the end of formal teaching;
- a total of 3627 'pages of content' (defined as a single HTML or PDF file) were viewed.

An average student usage of over 60 pages and the high level of personal usage, for consolidation and revision, over the vacation and examination period was encouraging for the first exposure of MELEES to students. A comparison plot is shown in Fig 3 of individual examination mark with their usage for those students using MELEES and confirms that the provision was seen as helpful to students from all ability ranges. In an email-based follow-up survey encouraging comments were received and feedback including the following comments:

"Very resourceful website. Good job."
"Without these I believe that I wouldn't have achieved 72% overall in this module!"
"It was all very useful, some bits were good to have but not really needed, but it's better to have too much than not enough."
"I think MELEES was a big help during the first semester. I wish it was more developed so that it was available to me during the second semester. Well done!!!!"

The top three helpful features considered by students were identified as example sheets and solutions, past exam papers and solution but also the interactive self-assessment (coursework) quiz. Most students responded that the site was easy to use but some did have initial difficulty with a separate MELEES password entry; this has been resolved with a new version of WebCT that links to the user's current password. Student access to documents suggest that direct reference on screen is the most popular and followed by printing and finally download to their own computer; development work is ongoing to provide the most effective mechanisms for each of these. Feedback also suggested additional features that might be included to aid transition from pre-university study that included: interactive practice tests to refresh knowledge at the start of the module, more mathematical examples, 'taster' example sheets of material that would be covered (helps give an idea of the level of mathematics needed). This latter item is perhaps useful within a provision that provides different pathways depending on a variety of different pre-university background experiences in mathematics.

Discussion

The e-learning framework has significant potential particularly in the following areas:

Access / wider participation – this will be a help to Client Schools who have the potential to widen access to students who are less well qualified on entry in mathematics to cope with the learning of the more technical and quantitative elements in Science and Engineering. A recent circular from Engineering bodies [3] identifies the current difficulties with the implementation of *Curriculum 2000* and A/S levels in Mathematics and their accreditation teams are instructed to be flexible on intake qualifications providing remedial support is available.

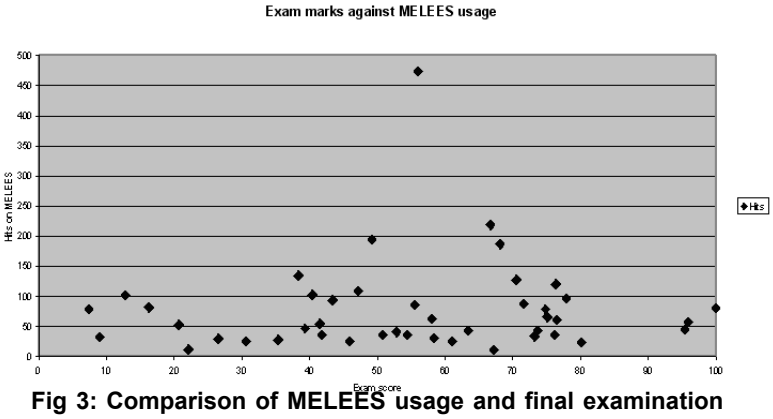

Fig 3: Comparison of MELEES usage and final examination module mark

Non-standard structures for learning– recently the last two Sessions, Mathematical Sciences was involved in developing a tailored learning framework for students on a pilot Partnership degree with the School of Electrical & Electronic Engineering where students interleave their studies with work. Students attend the University on the basis of about one in three weeks and are supported by pre-prepared module materials, tutorials and e-mail support. Most of these aspects could be more effectively administered and monitored within an e-learning framework and has potential as a basis for more flexible degree studies or for specialist courses for Continued Professional Development within Industry.

Conclusions

The advent of 'e-learning' within HE in recent years has set a new challenge for teaching staff to embrace and develop. The new medium offers new potential:

- To encourage self-directed learning (through expanding the learning resource base and flexible structuring of the resources)
- To broaden the range of teaching and learning activities (through incorporation of motivating examples, interactive links, etc)
- To address the needs of 'non-standard' students (from gap or placement years, broader access qualifications, disabilities such as dyslexia or visually impaired, etc)
- To gateway access to a wealth of national and international learning resources
- To improve communication (between student, teaching staff and client Schools in Engineering) and link the mathematics provision more directly to the students' engineering courses
- To encourage and disseminate good and innovative practice in support of high quality teaching and learning

The MELEES project has made an initial start in embedding the use of web-based technology to create a sound, flexible and sustainable infrastructure for delivering Mathematics support. It is recognised that significant development is required and this must be led by the interests of both staff and students in a coordinated and evaluative manner and where possible by sharing experiences within the academic community. Following initial implementation the following attributes have been identified:

For Students and Client Schools:

- Provides a comprehensive, consistent and easily accessed facility
- Can readily access materials of a variety of types from a wide range of sources (third-party, motivation, information and technical)
- Fast reaction time for feedback on assessments, provision of additional resources or updates to existing materials
- Focused and scheduled module learning support
- Links to other web resources (including Client Schools)
- Direct communication & feedback to/from teaching and support staff
- Potential for students with disabilities (physical disability, dyslexic and partially-sighted) to gain more targeted and effective help
- Provision for Client Schools to readily obtain information on detailed module information (Course/module planning, programme specifications, accreditation)

For teaching staff:

- Web-based environment under WebCT - University supported, flexible (with some constraints), readily updated, low maintenance
- Does not require in-depth knowledge of Web code/Web design to operate (basic IT skills needed)

- Provision of templates & help information for main tasks.
- Can readily incorporate materials of a variety of types from a wide range of sources.
- Learning support materials readily updated and shared.
- Materials can be pre-prepared and 'timed for release' .
- Potential for excellent communication & feedback to students, pg demonstrators and Client Schools
- Potential to more readily help students with disabilities (physical disability, dyslexic and partially-sighted)

The planned two-year development remains at a formative stage, but implementation on an initial framework has received very positive feedback from students, teaching staff and interest from Client Schools. The provision for the next academic Session will be expanded to over fifteen service mathematics modules and also to include more interactive e-learning elements together with directed gateway access for students to the growing number of high quality networked resources as highlighted recently by Kelly [4].

Acknowledgment

MELEES is funded by the 'e-Learning Strategy Project Development Fund', University of Nottingham.

References

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[2] *Enhancing the Total Learning Environment for students*, 2002, Petocz P and Reid A (2002), in Effective learning and teaching in Mathematics & its applications, ed. P Kahn & J Kyle, Kogan Page Ltd, London

[3] *Maths Problem*, 2003, New Civil Engineer, 16 January

[4] *Resources Guide for Engineering, Mathematics and Computing*, Kelly S, MSOR Connections Vol 3, No.2, May 2003

Monthly series on Computer-Aided Assessment in Maths http://ltsn.mathstore.ac.uk/articles/maths-caa-series

Computer-Aided Assessment (CAA) is likely to become an important form of testing in the next decade, and we have initiated a series of monthly articles on CAA in mathematics. Please read the articles as they appear and send your comments to the discussion list maths-caa@jiscmail.ac.uk. Below are summaries of some recent contributions. You are invited to suggest articles for this series by contacting the series editor Cliff Beevers, email c.e.beevers@hw.ac.uk

May 2003: TAL - A National Database of Questions – Classification is the Key
Contributed by Jon Sims Williams and Mike Barry of Bristol University

This paper discusses a CAA system called TAL. TAL is unusual in that it allows users to generate large numbers of equivalent tests from a specification. The tests are generated from a database of questions and all questions must be classified. Some of the difficulties involved in classifying questions are discussed.

June 2003: Incorporating assessment into an Interactive Learning Environment for mathematics
Contributed by Manolis Mavrikis and Antony Maciocia of The University of Edinburgh

In this article, after briefly describing a web-based Interactive Learning Environment (WALLIS) and the reasons for incorporating assessment into it, the approach to implementing formative CAA is described. This has recently been pilot-tested with a first year honours group of students.

July 2003: Mathematics Assessment at a Distance
Contributed by Sally Jordan, Philip Butcher and Shelagh Ross of The Open University

This article considers the development of a Web-based assessment system by which remote students take a credit-bearing test online at the end of the Open University 'Maths for Science' course. During the test the students receive immediate, targeted feedback on their answers, and are awarded a mark that reflects the amount of help they have been given.